Claims

1. A method of processing particulate material, including the steps of:

supplying the particulate material to a separator;

monitoring a parameter of the separator indicative of a separation value of the material;

determining from said parameter an induced value indicative of the separating efficiency of the material that passed through said separator;

comparing said value with a predetermined value; and

generating an alarm condition if the said value departs from the predetermined value by a predetermined amount.

2. The method of claim 1 wherein the separator is a medium dense separator and the separation value comprises the separating density of the separator.

3. The method of claim 1 wherein the separator is a classifying separator and the separation value is the separation size of the material at which separation is to take place.

4. The method of claim 1 wherein the separator comprises a heavy medium device containing a dense medium.

5. The method of claim 1 wherein the step of determining the induced value comprises determining an induced set of values indicative of the separating efficiency of the material that passed through the device, the step of comparing said value comprises comparing said set of values with a predetermined range for the set of values, and the step of generating the alarm condition comprises generating the alarm condition if the said set of values departs from the predetermined range for the set

of values by a predetermined amount.

6. The method of claim 5 wherein the set of values is in the form of a partition coefficient curve and parameters derived therefrom.

7. The method of claim 1 wherein the parameter which is monitored is the actual density of the medium.

8. The method of claim 1 wherein the parameter is pressure of the medium and particle mixture which is supplied to the device.

9. The method of claim 1 wherein the parameter is the feed rate of the medium and particle mixture supplied to the device.

10. The method of claim 1 wherein the parameter is the overall processing plant feed rate.

11. The method of claim 1 wherein the parameter is the ratio of volume or mass flow rate of medium to the volume of mass flow rate of the material.

12. The method of claim 1 wherein the parameter is two or more of the medium density, pressure of the medium and particle mixture, feed rate of the medium and particle mixture, and ratio of volume or mass flow rate of medium to the volume of mass flow rate of the material.

13. The method of claim 7 wherein the density of the medium is measured at predetermined time intervals, and for a predetermined time period, the number of measurements at each measured value is determined to produce a cumulative normalised frequency distribution of the length of time the particle spends at each measured density, and said set of values characterising separating efficiency is determined as a medium induced partition

coefficient curve and/or a parameter derived therefrom, for example medium induced Ep value (MIEp value) by taking the absolute value of the difference in density at the 75th and 25th percentiles, and dividing by 2000 so as to produce an MIEp value which is a theoretical value solely dependent on medium density variations, and comparing the MIEp value with the said predetermined value, or medium induced partition coefficient curve with a predetermined partition coefficient curve.

14. The method according to claim 8 wherein a pressure induced partition coefficient curve is derived by taking the absolute value of the difference in pressure at the 75th and 25th percentiles, and dividing by 2000 so as to produce a PIEp value which is a theoretical value dependent on pressure variations and comparing the PIEp value with the said predetermined value, or pressure induced partition coefficient curve with a predetermined partition coefficient curve.

15. The method according to claim 14 wherein a pseudo PIEp value is used as the PIEp value to avoid the need for calibration.

16. The method according to claim 10 wherein a feed rate induced partition coefficient curve is derived by taking the absolute value of the difference in feed rate at the 75th and 25th percentiles, and dividing by 2000 so as to produce a FRIEp value which is a theoretical value dependent on feed rate variations and comparing the FRIEp value with the said predetermined value, or feed rate induced partition coefficient curve with a predetermined partition coefficient curve.

17. The method according to claim 16 wherein a pseudo FRIEp value is used as the FRIEp value to avoid the need for calibration.

18. The method according to claim 11 wherein a ratio of medium to material induced partition coefficient curve is derived by taking the absolute value of the difference in ratio at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce a MCRIEp value which is a theoretical value dependent on ratio variations and comparing the MCRIEp value with the said predetermined value, or ratio induced partition coefficient curve with a predetermined partition coefficient curve.

19. The method according to claim 18 wherein a pseudo MCRIEp value is used as the MCRIEp value to avoid the need for calibration.

20. An apparatus for processing particulate material, comprising:

means for supplying the particulate material to a separator;

means for monitoring a parameter of the separator indicative of a separation value of the material;

processing means for determining from said parameter an induced value indicative of the separating efficiency of the material that passed through said separator;

comparing means for comparing said value with a predetermined value; and

alarm means for producing an alarm condition if the said value departs from the predetermined value set by a predetermined amount.

21. The apparatus of claim 20 wherein the separator comprises a heavy medium device.

22. The apparatus of claim 20 wherein the processing means is for determining from said parameter an induced set of values indicative of the separating efficiency of the material that passed through the device, the comparing means is for comparing the said value set with a

predetermined value set and the alarm means is for producing the alarm condition if the set of values departs from the predetermined value set by a predetermined amount.

23. The apparatus of claim 20 wherein the parameter is density of medium, and the monitoring means is for measuring the density of the medium at predetermined time intervals, and for a predetermined time period, and the processing means is for determining the number of measurements at each measured value to produce a cumulative normalised frequency distribution of the length of time the particle spends at each measured density, and for determining said value set as a medium induced partition coefficient curve and/or parameters derived therefrom by taking the absolute value of the difference in relative density at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce an MIEp value which is a theoretical value solely dependent on medium density variations, and comparing the partition coefficient curve and parameters derived therefrom with the said predetermined value set.

24. The apparatus according to claim 20 wherein the parameter is feed rate and the processing means is for determining a feed rate induced partition coefficient curve by taking the absolute value of the difference in feed rate at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce a FRIEp value which is a theoretical value dependent on feed rate variations and comparing the FRIEp value with the said predetermined value, or feed rate induced partition coefficient curve with a predetermined partition coefficient curve.

25. The apparatus according to claim 24 wherein a pseudo FRIEp value is used as the FRIEp value to avoid the need for calibration.

26. The apparatus according to claim 20 wherein the parameter is pressure and the processing means is for determining a pressure induced partition coefficient curve by taking the absolute value of the difference in pressure at the 75th and 25th percentiles, and dividing by 2000 so as to produce a PIEp value which is a theoretical value dependent on pressure variations and comparing the PIEp value with the said predetermined value, or pressure induced partition coefficient curve with a predetermined partition coefficient curve.

27. The apparatus according to claim 26 wherein a pseudo PIEp value is used as the PIEp value to avoid the need for calibration.

28. The apparatus according to claim 20 wherein the parameter is material to medium ratio and the processing means is for determining a ratio induced partition coefficient curve by taking the absolute value of the difference in ratio at the 75th and 25th percentiles, and dividing by 2000 so as to produce a MCRIEp value which is a theoretical value dependent on ratio variations and comparing the MCRIEp value with the said predetermined value, or ratio induced partition coefficient curve with a predetermined partition coefficient curve.

29. The method according to claim 28 wherein a pseudo MCRIEp value is used as the MCRIEp value to avoid the need for calibration.

30. A method of determining the efficiency of separation of particulate material supplied to a separator, comprising the steps of:

monitoring a parameter of the separator indicative of a separation value of the material;

determining from said parameter an induced value indicative of the separating efficiency of the material that pass through the separator; and

using the induced value to provide a measure of the efficiency of separation.

31. The method of claim 30 wherein the step of determining the induced value comprises determining an induced set of values indicative of the separating efficiency of the material that passed through the device, the step of comparing said value comprises comparing said set of values with a predetermined range for the set of values, and the step of generating the alarm condition comprises generating the alarm condition if the said set of values departs from the predetermined range for the set of values by a predetermined amount.

32. The method of claim 31 wherein the set of values may be in the form of a partition coefficient curve and parameters derived therefrom.

33. The method of claim 31 wherein the parameter which is monitored is the actual density of the medium.

34. The method of claim 31 wherein the parameter is pressure of the medium and particle mixture which is supplied to the device.

35. The method of claim 31 wherein the parameter is the feed rate of the medium and particle mixture supplied to the device.

36. The method of claim 31 wherein the parameter is the overall processing plant feed rate.

37. The method of claim 30 wherein the parameter is the ratio of volume or mass flow rate of medium to the volume of mass flow rate of the material.

38. The method of claim 30 wherein the parameter is two or more of the medium density, pressure of the medium

and particle mixture, feed rate of the medium and particle mixture, and the ratio of volume or mass flow rate of medium to the volume of mass flow rate of the material.

39. The method of claim 33 wherein the density of the medium is measured at predetermined time intervals, and for a predetermined time period, the number of measurements at each measured value is determined to produce a cumulative normalised frequency distribution of the length of time the particle spends at each measured density, and said set of values characterising separating efficiency is determined as a medium induced partition coefficient curve and/or a parameter derived therefrom, for example medium induced Ep value (MIEp value) by taking the absolute value of the difference in density at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce an MIEp value which is a theoretical value solely dependent on medium density variations, and comparing the MIEp value with the said predetermined value, or medium induced partition coefficient curve with a predetermined partition coefficient curve.

40. The method according to claim 36 wherein a feed rate induced partition coefficient curve is derived by taking the absolute value of the difference in feed rate at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce a FRIEp value which is a theoretical value dependent on feed rate variations and comparing the FRIEp value with the said predetermined value, or feed rate induced partition coefficient curve with a predetermined partition coefficient curve.

41. The method according to claim 40 wherein a pseudo FRIEp value is used as the FRIEp value to avoid the need for calibration.

42. The method according to claim 34 wherein a pressure induced partition coefficient curve is derived by

taking the absolute value of the difference in pressure at the 75th and 25th percentiles, and dividing by 2000 so as to produce a PIEp value which is a theoretical value dependent on pressure variations and comparing the PIEp value with the said predetermined value, or pressure induced partition coefficient curve with a predetermined partition coefficient curve.

43. The method according to claim 42 wherein a pseudo PIEp value is used as the PIEp value to avoid the need for calibration.

44. The method according to claim 37 wherein a ratio of material to medium induced partition coefficient curve is derived by taking the absolute value of the difference in ratio at the 75th and 25th percentiles, and dividing by 2000 so as to produce a MCRIEp value which is a theoretical value dependent on ratio variations and comparing the MCRIEp value with the said predetermined value, or ratio induced partition coefficient curve with a predetermined partition coefficient curve.

45. The method according to claim 44 wherein a pseudo MCRIEp value is used as the MCRIEp value to avoid the need for calibration.

46. The use of the measure of efficiency determined according to claim 18 to adjust a processing plant to more efficiently separate the material.

47. An apparatus for processing particulate material, comprising:

means for supplying the particulate material to a separator;

means for monitoring a parameter of the separator indicative of a separation value of the material; and

processing means for determining from said parameter an induced value indicative of the separating

efficiency of the material that pass through said separator to thereby provide a measure of the efficiency of the apparatus.

48. The apparatus of claim 47 wherein the separator comprises a heavy medium device.

49. The apparatus of claim 47 wherein the processing means is for determining from said parameter an induced set of values indicative of the separating efficiency of the material that passed through the device, the comparing means is for comparing the said value set with a predetermined value set and the alarm means is for producing the alarm condition if the set of values departs from the predetermined value set by a predetermined amount.

50. The apparatus of claim 47 wherein the parameter is the density of the medium, and the monitoring means is for measuring the density of the medium at predetermined time intervals, and for a predetermined time period, and the processing means is for determining the number of measurements at each measured value to produce a cumulative normalised frequency distribution of the length of time the particle spends at each measured density, and for determining said value set as a medium induced partition coefficient curve and/or parameters derived therefrom by taking the absolute value of the difference in relative density at the 75^{th} and 25^{th} percentiles, and dividing by 2000 so as to produce an MIEp value which is a theoretical value solely dependent on medium density variations, and comparing the partition coefficient curve and parameters derived therefrom with the said predetermined value set.

51. The apparatus according to claim 47 wherein the parameter is pressure and the processing means is for determining a pressure induced partition coefficient curve

is derived by taking the absolute value of the difference in pressure at the 75th and 25th percentiles, and dividing by 2000 so as to produce a PIEp value which is a theoretical value dependent on pressure variations and comparing the PIEp value with the said predetermined value, or pressure induced partition coefficient curve with a predetermined partition coefficient curve.

52. The method according to claim 51 wherein a pseudo PIEp value is used as the PIEp value to avoid the need for calibration.

53. The method according to claim 47 wherein the parameter is feed rate and the processing means is for determining a feed rate induced partition coefficient curve by taking the absolute value of the difference in feed rate at the 75th and 25th percentiles, and dividing by 2000 so as to produce a FRIEp value which is a theoretical value dependent on feed rate variations and comparing the FRIEp value with the said predetermined value, or feed rate induced partition coefficient curve with a predetermined partition coefficient curve.

54. The method according to claim 53 wherein a pseudo FRIEp value is used as the FRIEp value to avoid the need for calibration.

55. The method according to claim 47 wherein the parameter is ratio of medium to material and the processing means is for determining a ratio induced partition coefficient curve by taking the absolute value of the difference in ratio at the 75th and 25th percentiles, and dividing by 2000 so as to produce a MCRIEp value which is a theoretical value dependent on ratio variations and comparing the MCRIEp value with the said predetermined value, or ratio induced partition coefficient curve with a predetermined partition coefficient curve.

56. The method according to claim 55 wherein a pseudo MCRIEp value is used as the MCRIEp value to avoid the need for calibration.